

International Journal of

SYSTEMS SCIENCE

*The Theory and Practice of Mathematical Modelling, Simulation,
Optimization and Control in relation to biological, economic,
industrial and transportation systems*

VOLUME 11

Editor: B. Porter

University of Salford, U.K.

Editorial Board:

| | | |
|----------------|-------|---------------|
| J. W. Bandler | - - | Hamilton |
| S. Barnett | - - - | Bradford |
| J. C. G. Boot | - - | Buffalo |
| R. C. Conant | - - | Chicago |
| F. H. George | - - | Brunel |
| R. Gorez | - - - | Louvain |
| L. T. Grujic | - - | Belgrade |
| S. C. Gupta | - - | Dallas |
| C. H. Houpis | - - | Ohio |
| G. J. Klir | - - - | Binghamton |
| M. E. Merchant | - | Cincinnati |
| J. Peklenik | - - - | Ljubljana |
| R. Perret | - - - | Grenoble |
| R. Rosen | - - - | Halifax |
| J. K. Sengupta | - | Santa Barbara |
| Y. Z. Tsypkin | - - | Moscow |
| J. L. Willems | - - | Ghent |

Subscription Information

USA, Canada and Mexico (air-freight): annual subscription (payable in advance), \$316.00; per part \$30.00 (surface post paid). Air-freighted to the USA and mailed from Jamaica, New York, by Publications Expediting Inc., 200 Meacham Avenue, Elmont, New York 11003. Second class postage paid at Jamaica, New York. US subscribers should send order and cheque (in favour of Taylor & Francis Ltd) to Account 04 810 879 Bankers Trust Company, P.O. Box 9137, Church Street Station, New York, N.Y. 10049, U.S.A.

Japan (accelerated surface post): apply to exclusive agents, Kinokuniya Company Ltd., Odakyu West Shinjuku Building, 47-1 Hatsudai 1-chome, Shibuya-ku, Tokyo 151, Japan. Telex 2322535.

Federal Republic of Germany (surface post): annual subscription (payable in advance), DM 471.00; per part DM 45.00 (surface post paid). Subscribers in F.R. Germany should send order and cheque (in favour of Taylor & Francis Ltd) to Account No. 073/6686, Deutsche Bank AG, BLZ 500 700 10, Postfach 2623, Rossmarkt 18, 6000 Frankfurt/Main 1.

UK and the rest of the world (surface post): annual subscription (payable in advance), £107.00; per part £10.00 (surface post paid).

Published monthly by Taylor & Francis Ltd, 4 John Street, London WC1N 2ET, U.K. Telex: 858540.

Printed by Taylor & Francis (Printers) Ltd, Rankine Road, Basingstoke, Hampshire RG24 0PR, U.K.

© 1980 Taylor & Francis Ltd. ISSN: 0020-7721.

CONTENTS OF VOLUME 11

NUMBER 1

| | |
|---|-----|
| Optimal feedback control laws using random sampling of the observation By Y. YAVIN | 1 |
| On measures for decision model structuring By D. W. RAJALA and A. P. SAGE | 17 |
| Selecting an optimal solution in stochastic linear programming By J. K. SENGUPTA | 33 |
| Identification of a distributed-parameter system with boundary noise By A. BAGCHI, R. C. W. STRIBOS and G. THÉ | 49 |
| A bounded optimization algorithm for capacity assignment in computer communication networks By C. A. NIZNIK | 57 |
| Stability of planar biped models by simultaneous pole assignment and decoupling By H. HEMAMI, C. S. ROBINSON and A. Z. CERANOWICZ | 65 |
| Stochastic optimal control theory and its computational methods By K. L. TEO, D. W. REID and I. E. BOYD | 77 |
| Identification of unknown parameters in linear discrete-time systems by a modified extended Kalman filter By T. YOSHIMURA, K. KONISHI, R. KIYOZUMI and T. SOEDA | 97 |
| Modelling communication and control between hierarchical systems By J. S. NICOLIS and E. N. PROTONOTARIOS | 107 |

NUMBER 2

| | |
|--|-----|
| Zero degree of difficulty programs and the distribution problem By C. H. SCOTT and T. R. JEFFERSON | 129 |
| Design of state observers for linear discrete-time systems By J. L. WILLEMS | 139 |
| Extended optimum ordering policies with discounting By N. KAIO and S. OSAKI | 149 |
| On the behaviour of dynamical systems subject to bounded disturbances By P. A. COOK | 159 |
| An assessment of two bootstrapping algorithms for the identification of the parameters of a dynamical system By D. SPREVAK and M. M. NEWMANN | 171 |

| | |
|--|-----|
| Continuous-time tracking systems incorporating Lur'e plants with single non-linearities | |
| By L.J. T. GRUJIĆ and B. PORTER | 177 |
| A dynamic model of housing | |
| By A. NAUDA, M. H. MICKLE and W. G. VOGT | 191 |
| Trajectory sensitivity reduction in non-zero-sum differential games | |
| By R. P. HÄMÄLÄINEN and T. EIROLA | 207 |
| Optimal control in some cancer chemotherapy problems | |
| By G. W. SWAN | 223 |
| Enumeration of all minimum feedback edge sets in a directed graph | |
| By P. K. SRIMANI | 239 |
| Parameter identifiability for distributed parameter systems of hyperbolic type | |
| By T. KOBAYASHI | 247 |

NUMBER 3

| | |
|--|-----|
| Identification of non-linear systems using correlation analysis and pseudo-random inputs | |
| By S. A. BILLINGS and S. Y. FAKHOURI | 261 |
| Optimal harvesting policies and regulations for renewable resources | |
| By M. SIMAAN and T. TAKAYAMA | 281 |
| Effect of system structure, connectivity, and recipient control on the sensitivity characteristics of a model ecosystem | |
| By T. G. WOLAVER | 291 |
| An impulse control policy for a class of jump diffusion processes | |
| By Y. YAVIN | 309 |
| Optimal control of partially observable jump diffusion processes | |
| By M. FRIEDMAN and Y. YAVIN | 323 |
| A direct method for parameter optimization | |
| By J. DOLEŽAL | 337 |
| Linear programming by nested decomposition: the primal decomplex method | |
| By C. A. DE KLUYVER | 345 |
| The role of observers in root locus design | |
| By B. KOUVARITAKIS | 355 |
| On certain investigations on self-diagnosable systems | |
| By N. DE, A. SENGUPTA, S. BANDYOPADHYAY and P. K. SRIMANI | 363 |
| Sampling strategies for the identification of compartment models | |
| By R. J. MULHOLLAND and R. J. WEIDNER | 377 |

| | |
|--------------------------|-----|
| Book review | 389 |
| Corrigendum | 391 |

NUMBER 4

| | |
|---|-----|
| Sensitivity analysis of goal programming with pre-emption By J. K. SHIM and J. SIEGEL | 393 |
| On identification of linear systems with feedback: high gain feedback case By B. KUSZTA and N. K. SINHA | 403 |
| Deadbeat control of single-input, single-output, linear, time-invariant systems By T. KACZOREK | 411 |
| Deadbeat control of single-input, single-output, linear, time-varying, time-discrete systems By T. KACZOREK | 423 |
| Modelling and estimation of traffic flow—a martingale approach By A. BAGCHI and M. VAN MAARSEVEEN | 429 |
| Load modelling of an interconnected power system for short term prediction By A. K. MAHALANABIS, M. HANMANDLU and R. S. RANA | 445 |
| Optimization of system reliability: a survey of problems and techniques By S. G. TZAFESTAS | 455 |
| A model of hierarchical ecosystems with utility efficiency of mass and its stability By H. HIRATA | 487 |
| Analysis of two-dissimilar-unit standby redundant system with administrative delay in repair By N. K. JAISWAL and J. V. KRISHNA | 495 |
| Subjective programming applied to optimal operation in automated warehouses By H. NAKAYAMA, Y. KARASAWA and S. DOHI | 513 |

NUMBER 5

| | |
|---|-----|
| Protein folding: a prototype for control of complex systems By R. ROSEN | 527 |
| Identification of a class of non-linear systems with gaussian non-white inputs By S. Y. FAKHOURI | 541 |
| Detection of abrupt change and trend in the time series By N. ISHII, A. IWATA and N. SUZUMURA | 557 |
| Trade-off analysis for optimal design of automated warehouses By Y. KARASAWA, H. NAKAYAMA and S. DOHI | 567 |

| | |
|---|-----|
| Estimating the parameters of autoregression processes by the method of least squares | |
| By A. S. POZNYAK | 577 |
| Analysis of a production-inventory control system for a diffusion department | |
| By J. W. M. BERTRAND | 589 |
| Incentives to cooperate in linear quadratic difference games | |
| By J. E. J. PLASMANS and A. J. DE ZEEUW | 607 |
| The conversion of linear time-varying systems to phase-variable canonical form | |
| By K. C. DALY | 621 |
| On the convergence of an associative learning algorithm in the presence of noise | |
| By E. OJA | 629 |
| Stable biased reduced order models using the Routh method of reduction | |
| By Y. SHAMASH | 641 |
| Correspondence: | |
| The aggregation problem and logistic growth | |
| By C. LEFEVRE | 655 |

NUMBER 6

| | |
|---|-----|
| Scattering theory and the discrete linear optimal control problem | |
| By J. WARRIOR and N. VISWANADHAM | 659 |
| Computer classification of the EEG time series by Kullback information measure | |
| By N. ISHII, H. SUGIMOTO, A. IWATA and N. SUZUMURA | 677 |
| Multidimensional block-pulse functions and their use in the study of distributed parameter systems | |
| By G. PRASADA RAO and T. SRINIVASAN | 689 |
| Identification both of the unknown plant and noise parameters of the Kalman filter | |
| By C. T. LEONDES and T. K. SIU | 711 |
| Structural modelling using a simple information measure | |
| By R. C. CONANT | 721 |
| Filter implementation for a linear stochastic distributed-parameter system with a moving boundary | |
| By T. YOSHIMURA, K. HIRATA and T. SOEDA | 731 |
| Extremal problems with an infinite number of inequality constraints | |
| By J. V. OUTRATA | 743 |
| A multimarket equilibrium valuation model | |
| By W. T. LIN | 753 |
| Digital simulation of Poisson stochastic differential equations | |
| By D. J. WRIGHT | 781 |

Research notes:

Pattern formation in a delay equation with diffusion

- By H. C. MORRIS and R. K. DODD 787

NUMBER 7

Matrix minimum principle for distributed parameter control systems

- By P. STAVROULAKIS and S. TZAFESTAS..... 793

Non-linear analysis of nitrogen cycle in aquatic ecosystems

- By T. MATSUMURA, and Y. SAKAWA..... 803

Design of linear multivariable discrete-time tracking systems incorporating fast-sampling error-actuated controllers

- By A. BRADSHAW and B. PORTER..... 817

Continuous-time tracking systems incorporating Lur'e plants with multiple non-linearities

- By B. PORTER and LJ. T. GRUJIĆ 827

Equivalent discrete optimal control problem for randomly sampled digital control systems

- By W. L. DE KONING 841

Practical design of feedback systems with uncertain multivariable plants

- By I. HOROWITZ and M. SIDI..... 851

Recursive estimation for a noisy image represented by a hyperbolic PDE model

- By T. KONOBU, S. OMATU and T. SOEDA 877

Evaluation of intersectoral investment allocation in India, 1951-1970; An application of stochastic optimal control by pseudo-inverse

- By D. R. BASU and A. LAZARIDIS 889

NUMBER 8

Kirchhoff interconnectability of linear constant dynamical systems

- By M. VOICU 907

Algebraic analysis of multiple faults in combinational networks

- By P. K. SRIMANI 921

Further studies on the problem of load modelling of an interconnected power system for short-term prediction

- By A. K. MAHALANABIS and M. HANMANDLU..... 937

Control policies for production-inventory systems with bounded input

- By A. BRADSHAW and Y. EROL..... 947

Influences of the input signal in non-linear parameter estimation

- By V. F. NICOLA, H. H. VAN DE VEN and P. EYKHOFF 961

The nature and significance of technological cycles

- By D. SAHAL..... 985

| | |
|--|------|
| High-order stiffly stable methods for analysis of non-linear circuits and systems | |
| By A. S. C. SINHA | 1001 |

| | |
|--|------|
| Computer control for low-order time-delay systems | |
| By A. THOWSEN | 1011 |

NUMBER 9

| | |
|---|------|
| Parameter estimation for auto-regressive systems with missing observations | |
| By P. B. MCGIFFIN and D. N. P. MURTHY | 1021 |

| | |
|--|------|
| Identifiability and identification of a Galerkin approximation for a class of distributed parameter systems | |
| By L. CAROTENUTO and G. RAICONI | 1035 |

| | |
|---|------|
| Design of linear multivariable discrete-time tracking systems incorporating fast-sampling decentralized error-actuated controllers | |
| By B. PORTER and A. BRADSHAW | 1051 |

| | |
|--|------|
| Discrete-time controllability for distributed parameter systems | |
| By T. KOBAYASHI | 1063 |

| | |
|--|------|
| Hitting a target with maximum probability | |
| By D. W. REID and K. L. TEO | 1075 |

| | |
|--|------|
| Design of multifunctional reduced order observers | |
| By F. W. FAIRMAN and R. D. GUPTA | 1083 |

| | |
|---|------|
| Heuristics free group method of data handling algorithm of generating optimal partial polynomials with application to air pollution prediction | |
| By H. TAMURA and T. KONDO | 1095 |

| | |
|--|------|
| Optimal non-linear estimation for distributed-parameter systems via the partition theorem | |
| By K. WATANABE, T. YOSHIMURA and T. SOEDA | 1113 |

NUMBER 10

| | |
|--|------|
| Lotka-Volterra-like approach to large-scale systems stability | |
| By LJ. T. GRUJIĆ and C. BURGAT | 1131 |

| | |
|--|------|
| Stochastic programs as non-zero sum games | |
| By J. K. SENGUPTA | 1145 |

| | |
|---|------|
| Dynamic compensation for exact model-matching of two-dimensional systems | |
| By P. N. PARASKEVOPOULOS and O. I. KOSMIDOU | 1163 |

| | |
|---|------|
| A method of predicting failure or life for stochastic systems by using autoregressive models | |
| By S. OE, T. SOEDA and T. NAKAMIZO | 1177 |

| | |
|--|------|
| A new finite-time linear smoothing filter | |
| By M. J. GRIMBLE | 1189 |

| | |
|---|------|
| On the application of multiple criteria decision making to a problem in defence systems acquisition | |
| By A. R. DEWISPELARE and A. P. SAGE..... | 1213 |
| Application of optimal control for determining the optimal price policy in the Greek cattle industry | |
| By A. LAZARIDIS | 1241 |

NUMBER 11

| | |
|--|------|
| Stable identification scheme for linear discrete-time systems | |
| By K. KONISHI, K. INOUCHI, T. YOSHIMURA and T. SOEDA | 1265 |
| Asymptotic properties of linear multivariable discrete-time tracking systems incorporating fast-sampling error-actuated controllers | |
| By A. BRADSHAW and B. PORTER..... | 1279 |
| A unified theory of decision principles | |
| By Y. TAKAHARA, B. NAKANO and K. KIJIMA | 1295 |
| Application of filtering methods in econometrics | |
| By A. LAZARIDIS | 1315 |
| Identification of a class of non-linear systems from short input/output records | |
| By S. Y. FAKHOURI..... | 1327 |
| A new decentralized controller for large scale systems | |
| By M. F. HASSAN and M. G. SINGH | 1335 |
| Optimal simultaneous maximum <i>a posteriori</i> estimation of states, noise statistics and parameters. I. Algorithm | |
| By D. SASTRY and M. GAUVRIT..... | 1351 |
| Optimal simultaneous maximum <i>a posteriori</i> estimation of states, noise statistics and parameters. II. Numerical performance | |
| By D. SASTRY and M. GAUVRIT..... | 1383 |

NUMBER 12

| | |
|---|------|
| Parameter adaptive control of stochastic distributed systems | |
| By S. G. TZAFESTAS | 1397 |
| Recognition and fuzzy description of sides and symmetries of figures by computer | |
| By B. B. CHAUDHURI and D. D. MAJUMDER | 1435 |
| An application of the stochastic automaton to the investment game | |
| By N. BABA, T. SOEDA, T. SHOMAN and Y. SAWARAGI..... | 1447 |
| Linear allocation rules under uncertainty | |
| By J. K. SENGUPTA | 1459 |
| Pole and zero retention in the factorization of multivariable systems, with application to model reduction | |
| By A. D. FIELD and D. H. OWENS | 1481 |

| | |
|---|------|
| A dynamical model for the vertical infiltration of water into the soil By K. PINGOUD and P. J. ORAVA..... | 1491 |
| Dimensionality reduction for a class of convex network flow problem By C. H. SCOTT, P. KERDVONBUNDIT and T. R. JEFFERSON..... | 1499 |
| Discrete-time tracking systems incorporating Lur'e plants with multiple non-linearities By J. T. GRUJIĆ and B. PORTER..... | 1505 |
| Book reviews | 1521 |
| Errata | 1523 |
| Subject index | 1525 |
| Author index (with titles)..... | 1531 |

